DOCUMENT RESUME

ED 205 169 IR 009 447

AUTHOR Fors, George, Ed.
TITLE Microcomputer Guide.
INSTITUTION North Dakota State Dept. of Public Instruction, Bismarck.
PUB DATE Sep 79
NOTE 51p.

EDRS PRICE MF01/PC03 Plus Postage.
DESCRIPTORS Career Awareness; *Computer Assisted Instruction; Computer Programs; *Computer Science Education; Elementary Secondary Education; Flow Charts; Mathematics Education; *Microcomputers; *Programing; Science Education; Spelling Instruction
IDENTIFIERS BASIC Programing Language; *North Dakota

ABSTRACT

Designed for use by school districts introducing computer mathematics into the curriculum, this manual provides guidelines for selecting a microcomputer system, as well as objectives and an outline for an introductory course in computer programming. Also presented are topics for computer applications in science, mathematics, chemistry, and physics, and three computer programs: (1) STAR PROBE, used to demonstrate the effects of gravitation and changes in velocity components (TRS-80 Level II BASIC); (2) Coefficients of Friction; and (3) Elemental Ratios for Empirical Formulas. Resources listed include textbooks on computer programming, references, periodicals, and a glossary of computer terminology. Programming information for a CAI spelling program, a descriptive outline of computer-related careers, and an introduction to flow charting (with examples) are appended. (LLS)

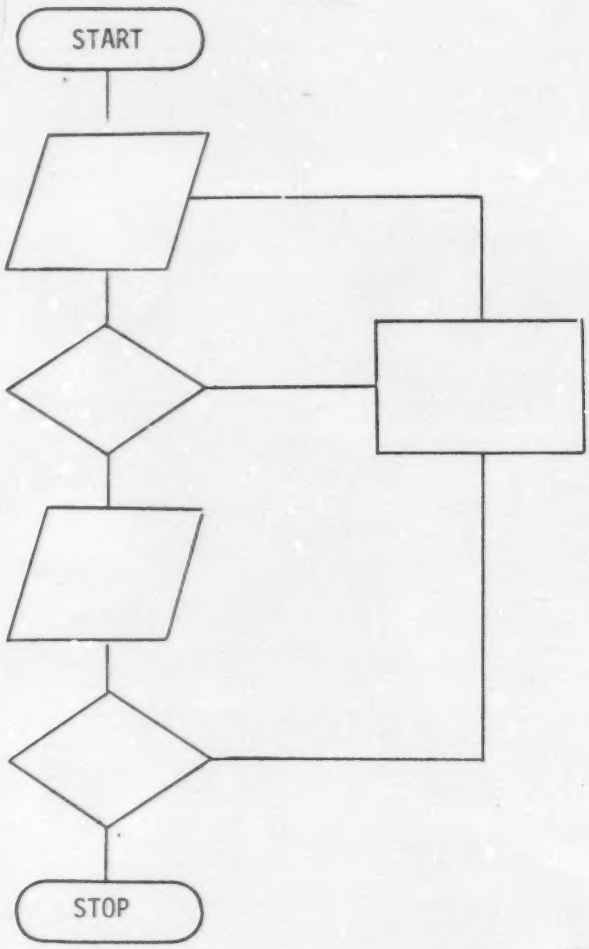
****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

MICROCOMPUTER GUIDE

ED205169

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY



"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
George Fors
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

Issued by

DEPARTMENT OF PUBLIC INSTRUCTION

Bismarck, North Dakota

HOWARD J. SNORTLAND, Superintendent

September, 1979

IR009447

FOREWORD

Computer exercises are common to many of the texts in introductory and advanced mathematics, used by the schools in North Dakota. The student is introduced to computing and computer programming in the context of this mathematical discipline while using a microcomputer to solve problems.

The mathematical material included in this course should be selected with a view toward exploiting the microcomputer to extend the student's knowledge of mathematics. Emphasis should be placed on problems and algorithms for their solution and not on formal proof of precisely stated theorems.

This microcomputer course should be thought of as transitional between the more conventional high school mathematics courses and more advanced subjects in mathematics, as well as an exploration of other computer applications to such areas as science, business, and the communication arts.

The use of the computer as an instructional tool allows the student to solve problems, develop insights, and make discoveries that otherwise would not be possible. The student's assignments should, therefore, consist of more reading and thought and less repetitive problem solving. In light of this, it can be seen that the need to build up a library of reference books and subscriptions to periodicals for instructors and students must be given a high priority.

It is the hope of the writers of this Guide that the exploratory aspect of the course not be overlooked, that every opportunity to emphasize computer application be fully utilized. In planning the course, provision should be made for on-site visits for students to observe computers in use and discuss with the users their applications, benefits, and some of the problems encountered.

ACKNOWLEDGMENT

Since 1967 staff members from the Department of Public Instruction have been endeavoring to assist school districts in introducing computer mathematics. In this effort we have been assisted by North Dakota State University and the University of North Dakota, which instituted a computer loan service. While these programs were successful, they were limited in the number of schools and pupils who could be reached. From these schools the consultant in science and mathematics was able to draw from a pool of teachers who have had special courses in computer programming, computer operation and in teaching computer mathematics, computer science, as well as other subjects such as spelling, English, and business education.

Using the research and materials assembled by the Mathematics Consultant, Mr. George Fors, the materials and classroom experience of the participating secondary teachers and university instructor, a writing team of 12 prepared this Microcomputer Guide.

With the increase in usage of the microcomputer in the schools of North Dakota, the Department of Public Instruction wishes to express its gratitude to the following persons who contributed to this publication.

Dr. Lowell Jensen
Deputy Superintendent

WRITERS

LINCOLN ARMSTRONG
Leeds Public School

ANTHONY KALAR
Grafton Public School

JOHN BRING
Cooperstown Public School

ERNEST KNUDSON
Bismarck Public Schools

AL DEGELE
Williston Public School

DAVID McCORMACK
North Shore Public, Makoti

MYRON FAA
Devils Lake Public School

JON McSPARRON
Clifford-Galesburg Public School

TERRY HAGGE
Mott Public School

GLEASON SACKMAN
Bottineau Public School

CONSULTANTS

KIARAN L. DOOLEY
Director, State & Federal Relations

GENE KEMPER
University of North Dakota

TYPISTS

MAVIS FRIED
Department of Public Instruction

MARY ANN MOUSEL
Department of Public Instruction

EDITOR

GEORGE FORS
Science and Mathematics Consultant

TABLE OF CONTENTS

Page

Foreword

Acknowledgment

Table of Contents

Part I -- Introduction

Goals 1
Introduction. 2
Why Computers in the Classroom? 3
Computers Offer Help for the Handicapped. 3
Computers in Education. 4
Potential Growth in North Dakota. 5
Computer Use (Now and in the Future). 6
Suggestions for Facilities and Usage. 7
Pre-Written Programs. 9
Computers in North Dakota Education 10

Part II -- Choosing A Microcomputer System

Choosing a Microcomputer System 11

Part III -- Outline

Computer Programming Course 15
How to Utilize the Course Outline 16
Introduction to Computer Programming (BASIC). 16
Teaching Suggestions. 19
Additional Outline. 20

Part IV -- Computer Application

Topics for Computer Application in the Science Classroom. . . 21
Topics for Computer Application in the Mathematics Classroom. 23
Star Probe Program. 25
Coefficients of Friction Program. 26
Elemental Ratios for Empirical Formulas Program 27
Chemistry Problems. 28
Physics Problems. 29

Part V -- Resources-Glossary

Textbooks 31
References. 31
Periodicals 34
Glossary. 35

Appendix

CAI Spelling Program. 39
Computer Careers. 41
Flow Charting 44

GOALS

LEARN TO SOLVE PROBLEMS.

DEVELOP LOGICAL THOUGHT PROCESS.

DEVELOP DESIRABLE ATTITUDES, INTERESTS, AND APPRECIATIONS.

REINFORCE MATHEMATICAL CONCEPTS.

DEVELOP UNDERSTANDING AND SKILL IN COMPUTATION.

ADAPT INSTRUCTION TO INDIVIDUAL ABILITIES, NEEDS, AND INTERESTS.

LEARN ABOUT COMPUTER OCCUPATIONS.

ACQUIRE BASIC COMPUTER VOCABULARY.

INTRODUCTION

The Department of Public Instruction recommends that a course in introductory computer programming be offered to tenth, eleventh, and twelfth grade students. An advanced programming course could be offered to eleventh and twelfth grade students. However, students in all grades are capable of operating a computer.

It is recommended that the courses be of one semester duration and receive one-half credit. A short course of nine weeks would receive one-fourth credit.

If the class is small, one microcomputer or one terminal connected to a central computer would be satisfactory.

These courses could be offered by any of these departments: mathematics, science, or business education. The teacher should have at least a minor in his/her department, plus one course or workshop in computer programming.

It is recommended that students in the introductory course have satisfactorily completed Algebra I. It is recommended that students in the advanced class have completed at least one year of mathematics beyond algebra and be taking at least a third year of mathematics. This background allows use of more math-oriented problems for programming exercises.

WHY COMPUTERS IN THE CLASSROOM?

Today the lives of everyone are touched by computers. Income taxes, magazine subscriptions, payroll checks, and credit accounts, to name just a few things, are all processed by computers. In the future, the life of everyone will be influenced by computers, automation, and perhaps robots. A large percentage of the students will be involved with computers and allied concepts. This will extend even to occupations which we do not now relate to computers. None of us can avoid computers. We are going to feel secure about computers only if we have some knowledge of them.

There is an intrinsic value to using computers in the classroom which is entirely unrelated to their possible future role in the life of the student. The computer requires a sequence of detailed and complete instructions to solve a problem. The student who undertakes to program a problem is committed to an analysis of the problem, the formulation of a solution, and the translation of this into instructions for the computer. The process is not unlike that used in more formal mathematics courses, but the range of problems (and the degree of student interest) is much broader.

Computers can motivate a large percentage of the students, and this motivation can be put to good use. We can, through the medium of a computer, excite the student about subjects that he normally shuns. Another benefit of using computers is the opportunity it affords many students to broaden their horizons and to enlarge generally their concept of what the future may hold for them.

The computer is causing a change in our society. Automation controlled by the computer is being used in industry: data processing by the computer is making accounting and record keeping an automatic process; scientific research now has practically instantaneous analysis of data; linear programming by the computer is a means of decision making in government, education, military science, agriculture, and business. Computer memories are being used to store entire courses for presentation to individual students (CAI). Medicine, law, and engineering are using information retrieval by the computer for diagnosis and decision making. Space travel and commercial plane scheduling are dependent on the computer.

Computer programming is of great interest to students of all abilities. For the slow learner, it is a new topic free of many of the frustrations and hostilities associated with topics which depend on concepts they have not yet mastered. For the culturally deprived, it gives a promise of new employment opportunities. Problems of different degrees of sophistication are available for the enrichment of almost every topic. For the gifted, it provides a tool for probing challenging problems free of monotonous computation. It meets individual needs.

COMPUTERS OFFER HELP FOR THE HANDICAPPED

Nowhere are the benefits of learning with personal computers more dramatic than with the handicapped, whose physical limitations have been a barrier to an education.

The small computer, coupled with an assortment of specially designed input and output techniques, can become a "voice" for those who have none, "eyes" for those who are sightless, and "ears" for the deaf. Many developments have been made, and many more are on the drawing board.

COMPUTERS IN EDUCATION

There is a wide variety of computer use in education today. The significant uses for elementary and secondary schools can be categorized in roughly three ways: (1) Instructional Computing, (2) Administrative Data Processing and (3) Instructional Support.

Instructional Computing is the most important use of the computer in education; it is a tool to be used in the primary activity of any school, that of instructing students. It is a type of computing that assists and augments classroom teachers in their role of teaching.

Administrative Data Processing is a term often applied to computing activities that typically support the school or district administration. These include accounting and finance reports, grade reporting, class scheduling and related activities. Such computing is for the purpose of assisting the administrative staff in performing the business functions of the school or district. Any effect it is likely to have on instruction will be indirect at most.

Instructional Support is somewhat related to Administrative Data Processing but can be thought of as providing useful services directly to the classroom teacher. These include class lists, test analysis, mechanical test scoring, record keeping for individualized learning programs and others.

In classical computer assisted instruction (CAI), the computer was viewed as a substitute instructor to a very large degree. With more careful use of this technique, it concentrates more heavily on drill, practice, record keeping, and administering tests. CAI has found a place where computers excel--that of performing monotonous, repetitive tasks where human beings easily tire. The advantage is not to replace the teacher, but rather to extend the teacher's time, creativeness, and resources--to assist in the individualization of instruction. The computer can administer drill and practice all day; teachers are seldom available on such a schedule, and their patience would be tried by such monotonous activity. CAI has been notably successful; where effectiveness has been evaluated. CAI has been shown to be a cost effective means of improving student skills. CAI activities alone could create a tremendous demand for computer time in the future--the technique requires that the student be physically present at the microcomputer terminal. Even with limited numbers of microcomputers it can be effective; the ten or fifteen minutes per day of undivided attention is better than little or no attention from an overworked teacher.

In a CAI spelling program (see appendix for listing of the program), for example, a student spends between ten and thirty minutes per week at a terminal. The student is shown a word for five seconds and then the word is blanked off the screen. The student must then correctly spell the word that has been shown. The computer then compares the answer with the correct spelling and rewards the student if it is correct. If the student has misspelled the word, the computer reprints the word with blanks where there are incorrect letters. Only when a correct spelling is provided by the student, does the computer go on to the next word. At the end of the session, the student is given a score based on the correct answers the student provides.

POTENTIAL GROWTH IN NORTH DAKOTA

1. The volume of use will be much greater. There will be more machines in each school. Many new teachers are being trained in computing through courses and workshops. They will provide both the demand as well as the expertise for computer use.

2. Computer use will extend into more subject areas. A number of subject areas that were often thought to have no interest in computing, such as English, social studies, biology, music, all make modest or considerable use of the computer now. This use is expected to grow.

3. Computer use will extend to more students. With teachers getting involved, they will eventually get their students involved. (The reverse phenomenon has also had a profound effect.)

4. Applications that are just emerging now will become very common. There will be more computer-assisted instruction (CAI) as it is merely waiting for implementation. More use for record keeping for individualized instruction (CMI) is also highly likely. In fact, one could expect increased activity in all the categories mentioned above.

5. Since most of the considerations directly involve curricula as well as computers, the need for consulting and assistance in implementing instructional programs will become even more prevalent. Though many teachers will be trained, other teacher support persons and administrators will need help in implementing programs.

6. While the microcomputer, at its low cost, is bringing the computer into North Dakota schools, it does have limitations. It can be used in CAI or in teaching BASIC programming. Small systems cannot be expected to do all the functions that a large computer can handle.

COMPUTER USE (NOW AND IN THE FUTURE)

Federal, state, and city governments have been and will continue to be great users of computer services. The computer will be used even more extensively in planning and decision making by analysis of statistics and data and increased use of simulations to test proposed plans. Government use varies from ecological control and planning, weather forecasting, military planning and budgets, government monetary planning, control and budgeting, population issues and predictions, and on and on. A research project called SEARCH (Systems for Electronic Analysis and Retrieval of Criminal Histories) is being developed primarily by the FBI--to contain the histories of every arrested person and to make these available to every law-enforcement agency.

In business and industry, computers allow the management of larger and larger organizations which undoubtedly will be subject to rather strict government control, but the overall effect of the larger computerized industry will be more efficient production and thereby cheaper products available to you.

In agriculture, much planning and scheduling will be computerized. A farmer may request a plan through perhaps the county agent and on the basis of soil samples and questionnaires, the computer may issue a complete program for the farmer detailing what crops to plant and when and what animals to raise, all for maximum production and profit.

In medicine, the computer will see even an increased use in the area of monitoring devices capable of monitoring various physical signs of many patients simultaneously and alert personnel on any dangerous deviations. There may be more and more computer use in laboratories for analysis and testing with far greater accuracy than humanly possible. The computer will be used in an interactive mode to obtain the medical history of a patient and may even make a rough preliminary assessment of specialty within which the complaints of the patient lie. In the actual diagnosis of disease, faster more accurate diagnosis may be made since the physician will have access to huge data banks of information dealing with symptoms and signs. However, since most diagnosis requires a degree of judgment, it is doubtful that complete computerized diagnosis is near.

One of the concerns of many people is the individual privacy they would like to enjoy. The fact is, of course, that there probably exist files on each of us somewhere already that we are not aware of. Even more than the problem of information being maintained on us is the question of (1) the validity of the information and (2) the accessibility of the information to unauthorized persons. The issue of privacy is of sufficient concern to have been the reason for recent legislation. However, most sources seem to agree that with assurances of security of information, people will more and more accept the existence of huge data files containing information about them.

Another big concern of computerization of society is job displacement and vast unemployment due to automation. However, at the same time, many new jobs have been created through the manufacture and utilization of computers. First, complete computerization of industry won't happen overnight leaving millions jobless. It will be a gradual transition hopefully with employers concerned with the welfare of their employees enough to make provision for retraining.

SUGGESTIONS FOR FACILITIES AND USAGE

1. The computer(s) can be contained within the classroom or can be contained in a separate room. A sturdy table on wheels can be of value in making the computer available to many classrooms. A separate center can be useful to provide student access through the entire day. Teachers who have the computer within their classrooms have found that students can come in from study halls without disturbing the class in session and thus get all day use of the classroom-located machine.

2. A good computer terminal to student ratio is 1 to 4. A suggested maximum ratio is 1 to 10 for the semester course. These are only suggestions. The primary concern is that the students enrolled in computer courses have adequate terminal access time to complete their assignments.

3. If programming students are not making full time use of available terminals, other students can be allowed to use pre-written programs for CAI. These students will need a minimal amount of instruction in loading and running programs. A simple instruction chart, located with the computer, helps the non-programming student.

4. If unused time remains, elementary students can benefit from exposure to a computer. Pre-written educational games can be used, and CAI work can be done beneficially.

5. Since the computer is applicable to many subject areas, the principal working with the computer is encouraged to introduce it to other teachers for enrichment of their classes. This also gives a greater number of students exposure to the computer.

6. Operating instructions should be posted near/at the computer. Hours when the computer is available for students or teachers should be posted. If anyone wants to reserve a certain time, the computer instructor should be contacted. If the computers are in a separate room, there should be no more than two to a computer, unless it is a class. As the days go by, a school will have to establish their own set of rules.

7. Program storage recommendations:

   a. Tapes should be of a high quality. Good quality iron oxide, i.e., low noise, audio tape is best. Within a brand, higher price usually means better quality. A polished, shiny tape surface or five-screw case, is a good indication of quality.

b. Tape heads and capstan should be cleaned often (at least monthly) with special cleaning solution which can be purchased in audio stores or with alcohol (not rubbing alcohol). Use of a Q-tip is recommended.

c. Tape heads, capstan, and guides should be demagnetized after cleaning with some type of tape head demagnetizer. Use manufacturers recommendations.

d. Tapes and the recorder should be handled properly as tape surface damage can cause program loss. Dust, fingerprints, liquids, etc., are to be avoided.

e. Short length cassettes (20 minutes or shorter) are advised so that one program is recorded per cassette, to avoid losing program location and speed access time. These can be obtained by special purchase for computer use.

f. Double record and check all programs when stored.

g. To erase a tape, use a bulk tape eraser rather than trying to record over an old recording. These can be purchased at an audio store.

h. If using a disk system, be sure to read the system's manual on diskette handling. In particular, diskettes can be easily damaged by fingerprints, smoke, dust, etc. Diskettes should not be cleaned or written on, should be kept in jackets, and stored vertically.

i. All magnetic storage media should be kept away from magnetic fields (near power supplier, speakers, monitors, etc.) and out of heat and direct sunlight. The storage area should not have too low a humidity.

PRE-WRITTEN PROGRAMS

With the present availability of the microcomputer, many teachers across the state are writing programs for their own use and in their own areas of teaching. It would be advantageous for teachers to have a mechanism for sharing these programs. If a program has already been written to accomplish a task, time is saved if the next teacher does not have to write his own.

The North Dakota Council of Teachers of Mathematics (NDCTM) has instituted a program exchange to facilitate such a sharing. Under this, a teacher may purchase programs (either tape or listing) at a minimal cost to cover tapes, postage, etc. Or, a teacher may submit his own programs to share with other teachers. For each program submitted, a teacher may receive in exchange two programs other teachers have submitted. The only charge at the present time is to cover postage.

The NDCTM Program Exchange can be reached by contacting: David McCormack, Makoti, ND 58756. School phone: 726-5591, Home phone: 726-5637.

Listed below are just a few of the programs that are available.

1. CM LINE GUESS - (TRS-80) I or II

   Computer prints a line - student guesses length in cm.

2. BASKETBALL STATISTICS PROGRAM - (TRS-80) I or II

   Handles stats for 8 items for each of 14 players. Stores data on tape for reentry when tallying next game.

3. BASIC MATH DRILL - (TRS-80) I or II

   Drills in +, -, x, ÷, whole number, decimal, fraction, and on six difficulty levels.

4. SURVEY RESULTS COMPILED - (TRS-80) I or II

   Will compile results and graph. Questions may have up to five responses. Will sort according to age, sex, education.

5. STATES AND CAPITALS QUIZ - (TRS-80) I or II

   Computer selects states and checks your answers for capitals.

6. INTEREST PACKAGE - (TRS-80) II

   Program calculates house payments, simple interest, compound interest and add-on loan payments. Good for business classes or general math.

7. STUDENT GRADE RECORD KEEPING - (TRS-80) I or II

   Program makes graphs of point totals and percents for grading period. Also stores cummulative data on tape.

8. STUDENT FINAL GRADE COMPUTATION - (TRS-80) I or II

   Loads cummulative data tape (above) and makes graphs for visual or percent grading at finals time.

COMPUTERS IN NORTH DAKOTA EDUCATION

The following is a history of the Department of Public Instruction's efforts to provide computer instruction in North Dakota.

1967 Mr. K. L. Dooley and Mr. George Fors, from the Department of Public Instruction, attended a conference on computers and mathematics instruction in Denver. This conference was funded by NSF and requested by the Council of State Supervisors of Mathematics.

1968 A four-week program was funded by NSF at the University of Denver to train teams of teachers to introduce a new twelfth grade curriculum in mathematics and computing to teachers in their regions. Three teachers attended from North Dakota. A follow-up workshop was held at NDSU for 22 advanced mathematics teachers from North Dakota schools. The NDSU Computer Center offered a mail-in service for computer programs. The teachers wrote programs and ran them in the computer.

1969 A computer workshop for ninth grade mathematics teachers was held at the University of North Dakota. Instructors from 20 school districts attended and experienced writing programs. There were 26 participants.

1971 The LOTT Project was initiated in the Grand Forks schools. This was an ESEA Title III program. A computer was installed with terminals in several different schools.

1972 A proposal on a Computer Loan Service was written and sent to NSF. The project was not funded. The North Dakota Conference on the Computer as It Applies to Classroom Instruction was held at UND.

1973 The UND Computer Center purchased a minicomputer, and this computer was loaned to six schools during the 1973-74 school year for one month at each school.

1974 During the 1974-75 school year, the Computer Loan Service had a computer in six schools. Discussion of a Statewide Computer Network for High Schools was held at the Spring Conference of the North Dakota Council of Teachers of Mathematics. Two computer workshops were held in the fall, one in Bismarck and one in Grand Forks. There were 42 participants.

1975 UND acquired another minicomputer and was able to have ten schools participate in the Computer Loan Service during the 1975-76 school year. The Legislature passed a resolution that the Legislative Council would study the possibility of a statewide computer system. A Computer Supplemental Science and Mathematics Workshop was held at Dickinson State College. There were 18 participants.

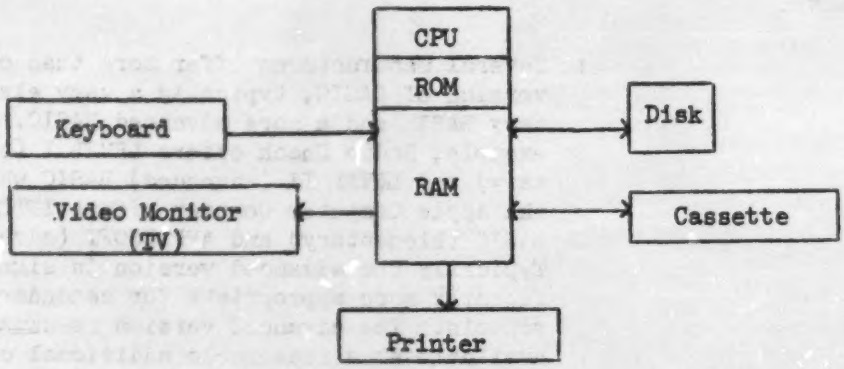
1978 Computer workshops were held in Bismarck and Grand Forks. The one-day workshops were devoted to the use of microcomputers.

1979 The first trial edition of *Microcomputer Guide* was written and distributed to schools.

CHOOSING A MICROCOMPUTER SYSTEM

Careful consideration must be given when choosing a microcomputer system for instructional use. Preferably, a school will first determine the uses for a computer in that school then examine a variety of potentially suitable computer systems. Whether or not this procedure is practical the problem of choosing an appropriate computer system remains. The purpose of this section is to present some considerations for effectively choosing a microcomputer system.

For our purposes, the parts of a computer system will be as described in the following diagram:



The CPU (Central Processing Unit) is the heart of the computer. It does all the processing required of the computer. The CPU is given instructions in a computer code called machine language. This language is very cumbersome and tedious to work with. Fortunately, there are easier languages to use, such as BASIC. The BASIC language is called a higher order language. It was designed to be relatively easy to use. The computer uses programs in BASIC but the CPU only understands machine language. Thus there is need of a computer program to translate the BASIC program into an equivalent machine language program. This translator program is contained in ROM (Read Only Memory). Fortunately this translation is done automatically for the user. When the user's program is entered into the computer, it is stored in RAM (Random Access Memory). Storage in a computer is often measured in bytes - one byte being the equivalent of one character (i.e. a letter, number or special symbol). A block of 1024 bytes is referred to as 1 K. For example, 4 K RAM means random access memory capable of storing 4 x (1024) or 4096 bytes. Thus, a rule-of-thumb is the larger the RAM the larger the program or the greater amount of data that can be accommodated. Another rule-of-thumb is the larger the ROM the more powerful the BASIC language. The rules-of-thumb are guidelines, not definitive statements.

The computer is controlled from the keyboard. Frequently the keyboard is also used to enter a program or data into the computer. The process of getting information (programs or data) into or out of the computer is called I/O (Input/Output). The keyboard is an input device. The

video monitor (sometimes a TV set) and the paper printer are output devices. The disk (sometimes called a floppy or mini disk) and cassette recorder are devices used for both input and output purposes. Information is magnetically stored on the disk and the cassette. Transfer of information to/from the disk is significantly faster than transfer to/from the cassette (often 200 times or more faster). A disk will also store more information than a cassette and the transfer of this information is more reliable than when using a cassette.

The beginning user will typically choose a computer system without regard to the particular CPU in the computer. This is an acceptable practice for choosing an introductory educational system. The other components included in a typical beginning computer system are the ROM, RAM, keyboard, video monitor and a cassette recorder/player. The following comments should be considered when evaluating these components:

ROM : Several manufactures offer more than one version of BASIC, typically a very elementary BASIC and a more advanced BASIC. For example, Radio Shack offers LEVEL I (elementary) and LEVEL II (advanced) BASIC while the Apple Computer Company offers INTEGER BASIC (elementary) and APPLESOFT (advanced). Typically the advanced version is significantly more appropriate for secondary schools. The advanced version is usually available at a reasonable additional cost (currently $99 for LEVEL II and $200 for APPLESOFT). The reason for the increase in APPLESOFT over INTEGER BASIC is that APPLESOFT includes high resolution graphics capability which provides for more flexible and powerful graphics.

There is considerable difference in the character sets (i.e. special characters) on the various microcomputer systems. For example, some character sets include spades, diamonds, hearts, clubs, Starship Enterprise, arrows, etc. Such character sets should be evaluated for their instructional value.

RAM : Typical beginning systems include 4 K or 8 K of RAM. For advanced students or large educational games it is frequently desirable to have at least 8 K, preferably 16 K. If a disk is included in the system, it is often necessary to have a minimum of 32 K of RAM.

Keyboard : Some computer systems have a keyboard with small keys (somewhat like a calculator) while others have larger keys much more like a typewriter. Some systems include a numeric keypad in the keyboard. This keypad provides for the entry of numbers without using the SHIFT key as on a typewriter.

Video Monitor : Output from the computer can be displayed on a video monitor (sometimes called a CRT) or a regular TV set. If the computer system comes with a video monitor then it might require an inexpensive (less than $40) additional device in order to use a regular TV set. Similarly, a computer designed to output to a regular TV set will require a modification to use a video monitor.

Another consideration with the computer system is the number of rows and columns of characters that can be displayed on the screen. When the computer scrolls the top line of text up off the screen, the text is lost. Thus, a large screen with several long rows of output might be appropriate for particular uses, especially in business related programs (payroll, accounts receivable, etc.)

Some computers are capable of displaying text or graphics characters in several colors. If color output is necessary, the number of potential computer systems is drastically reduced.

Cassette Recorder/Player: Frequently it is convenient to save programs or data. Temporary mass storage is inexpensively provided on standard tape cassettes. A standard inexpensive cassette recorder/player is interfaced with the computer as the input/output device.

If additional capabilities are desirable that are not provided by the beginning system, then the computer system will need to be expanded by adding one or more peripherals. Two of the most frequently added peripherals are a disk (floppy disk or diskette) and a printer. The following comments are pertinent when considering these peripherals:

Disk : A magnetic disk provides mass storage of information. As previously mentioned, transfer of information to/from a disk is much faster and more reliable than when using a cassette. Disk storage is more convenient to use than cassette storage.

A system using a disk will typically require a minimum of 32 K RAM for effective use of the system. Many computer systems have the capability of accommodating more than one disk drive.

Printer: A printer provides paper output (sometimes called hard copy). Printers are available that use narrow (2 1/4" - 6") special coated (electrostatic) paper. Although initially these printers are less expensive than printers that use wider regular paper the extra cost of the special paper might be considerable over time.

Printers that use wider regular paper are either of the friction feed or tractor feed variety. If a printer is to be used to fill out special forms or for multiple copies, then a tractor feed printer is usually recommended.

There are several other peripherals that are desirable for special purpose needs including audio devices used in music training and game paddles used for special input interaction with the computer (not restricted to games).

The following additional considerations are important factors in system selection:

1. An educational system should have complete and understandable documentation. Particular attention should be given to the BASIC manual for the system to insure that it is usable by the teacher.

2. Arrangements for repair service should be available in a reasonably local area.

3. It might be desirable to have a system that is expandable using peripheral devices available from the computer manufacturer.

4. Portability might be important in certain educational settings. For instance, a compact system with several or all of the components in one module would be convenient when the system will be moved from room to room.

ONE OF THE MOST INFORMATIVE ACTIVITIES IN CHOOSING A MICROCOMPUTER IS TO VISIT A SCHOOL WHICH IS USING A MICROCOMPUTER FOR INSTRUCTIONAL PURPOSES.

COMPUTER PROGRAMMING COURSE

Computer programming is designed to familiarize the student with the development of computers, their impact on the advancement of technology, and their many uses in solving problems in mathematics, science, business, and other disciplines. Emphasis is placed on analyzing problems, designing algorithms and flow charts preparatory to writing and executing programs, and analyzing results. Also stressed is the combined use of mathematics and the computer in developing systematic procedures for solving problems in the various disciplines. An in-depth study must be made of a selected language (or languages) appropriate for the computer available to the particular school system.

General Objectives

The following are broadly stated objectives which identify knowledge, skills, concepts, and attitudes expected as general learning outcomes upon successful completion of this course.

1. The student develops an acute awareness of the impact of computers on our society.
2. The student learns to appreciate the influence computers have had on the advancement of technology.
3. The student gains a good understanding of the development of computers.
4. The student learns to appreciate the versatility of the computer.
5. The student gains knowledge that computers are widely used as a problem-solving tool.
6. The student develops new techniques of problem solving and reinforces and extends previously learned techniques.
7. The student writes, debugs, and modifies computer programs.
8. The student gains a better understanding and mastery of mathematical concepts and is able to communicate them.
9. The student designs algorithms and constructs flow charts.
10. The student uses the computer as a problem-solving tool.
11. The student explores and researches problems of interest to the individual.
12. The student uses the computer to simulate experiments and games.
13. The student applies mathematical principals to solve problems in other disciplines.
14. The student becomes aware of careers related to computers.

HOW TO UTILIZE THE COURSE OUTLINE

The outline which follows is meant only as a guide and the order does not have to be strictly adhered to. However, it is suggested that all items listed be covered in the one semester course.

The outline, as presented, does represent a logical order which the first-time teacher could follow as a chronological guide. After once through the course, the instructors should certainly feel free to rearrange the outline to suit their individual preferences. Additionally, the particular system may or may not have all the statements indicated in the outline. However, the statements included in this outline are common to most BASIC interpreters.

Never assume that you are completely finished with a topic. As you teach this course you will find that you will constantly be reinforcing and supplementing the student's programming knowledge.

It is, of course, necessary to assign problems utilizing new commands as they are introduced. Sample problems can be made up or found in most programming books.

INTRODUCTION TO COMPUTER PROGRAMMING (BASIC)
One Semester Course

I. Components of a Computer
   - A. CPU (control and arithmetic logic)
   - B. Mem--RAM, ROM
   - C. Input/Output
   - D. Software/Hardware
     1. Computer languages--ForTran, CoBOL, etc.
     2. Computer applications
        - a. Data processing
        - b. Information retrieval

II. Communication with Computer
   - A. Immediate mode (calculator mode)
   - B. Programs (definition, running)
   - C. Error messages

III. Getting the System Up
   - A. Peripheral devices
     1. Keyboard
     2. Monitor
     3. Mass storage devices--recorder, disk, etc.
     4. Printers
   - B. System powerup sequence

IV. The LET Statement (Defining Variables)
   - A. Statement format (e.g. 10 LET X = 4)
   - B. Argument
     1. Variables
     2. Operation hierarchy
        - a. Parenthesis
        - b. Exponents, multiplication, division, addition, subtraction

3. Special symbols used

V. The PRINT Statement (Outputting)

A. Statement format (e.g. 10 PRINT X*3.14)
B. Arguments--variables, strings, and expressions
C. Simple formatting--quotes, commas, semicolon
D. Routing to printers (optional)
Note: Some BASIC versions require END statements.

VI. Simple Editing

A. Back space
B. New line substitution
C. DELETE
D. Memory clearing (NEW, SCR, etc.)

VII. LISTing

A. Complete listings
B. Individual line listings
C. Listing blocks of programs
D. REM statement
E. Routing to printers (optional)

VIII. RUNning

A. RUN complete programs
B. RUN from specific line number
C. Panic button (break key, CTRL/C, etc.)

IX. Program Storage and Retrieval

A. Saving programs on tape/disk
B. Loading programs from tape/disk
Note: Teaching of disk system usage is probably <u>not</u> desirable at this time.

X. The INPUT Statement

A. Numeric input
B. String input (this should probably be taught later, but introduced at this point)

XI. The READ-DATA Statement

A. The DATA format (numerical data)
B. READing data and the data pointer
C. RESTORE
D. String DATA format

XII. Flow Charting, Program Control, and Documentation

A. Unconditional branches
B. Conditional branches (decision making)

XIII. The GOTO Statement

XIV. The IF-THEN Statement

A. Relational Operators

B. Using the IF Statement
   1. Redefining variables
   2. Control (conditional branching)
C. Counters and simple loops

XV. The FOR-NEXT Statement

A. Simple loops
B. Nested loops
C. STEP (automatic counter)

XVI. Editing and Debugging

A. Debugging methods (tracing, flags, PRINTs, Immediate Mode)
B. EDIT mode--Avoid trying to teach all editing commands at one time. Teach a few of the most useful ones and add others when and if needed.
   Note: Systems usually have special tracing commands. Check your systems manual.

XVII. Numeric Arrays/Subscripted Variables

A. DIM statement
B. Single subscripts
C. Double subscripts
D. Matrices (optional)

XVIII. Special Branching Statements

A. GOSUB-RETURN
B. ON-GOSUB-RETURN
C. ON-GOTO

XIX. Functions (Internal Subroutines)

A. INT function and special uses
B. RND function and special uses (check your systems manual)

XX. Other Functions (SQR, ABS, LOG, EXP, etc., and Trigonometric Functions

XXI. Special Formatting

A. TAB function
B. PRINT formatting (Check your systems manual)

XXII. Strings

A. String variables
B. String functions--Use care to not overwhelm the student. Pick a few of the most important--(CHR$, MID$, LEFT$, and LEN$ are perhaps most important).
C. READ-DATA format
D. INPUTing and PRINTing

XXIII. Graphics--See Your Systems Manual.

XXIV. Historical Background of Calculating Devices and Computers (Use throughout the course)

XXV. Societal Impact of Computers (Use throughout the course)

(Also see page 20)

TEACHING SUGGESTIONS

1. Available films could be interspersed with other coursework to increase computer awareness.

2. Specific programs used to reinforce and demonstrate proficiency in use of different commands should be assigned as required.

3. Free periods for running game programs, if used in moderation, promote interest and allow relief from routine.

4. Running and critiquing of other students' programs allow students to see the programming techniques of others and be more aware of shortcomings in their own programs.

5. Get an unlisted phone number and hide during free periods to avoid constant questions from exuberant students or exasperated teachers, administrators, etc.

6. The history of computing could be interspersed with the teaching of the programming.

7. Students should learn to manually trace programs, keeping track of variable values, data pointer, and program pointer.

8. Students should have programs tentatively composed before coming to the keyboard.

9. Terminology should be introduced continuously and as early as possible.

10. Career information is an important aspect of all courses, but is especially important in this course.

ADDITIONAL OUTLINE

The material in this outline is probably not necessary in learning to write computer programs. However, the information should become a part of the knowledge of a student interested in computers. It can be presented to the students in a variety of ways and at various intervals. Some of this material can be supplemented into various courses, even if a computer programming course is not offered.

I. The History of Calculating Devices and Computers

- A. Early counting and the tally
- B. The counting board and the abacus
- C. Napier's rods and the slide rule
- D. Machines that led to the computer
  1. Blaise Pascal - 1642 - a machine that would add
  2. Gottfried Wilhelm Leibniz - 1694 - Leibniz Wheel - multiply and divide
  3. Joseph Marie Jacquard - 1801 - loom controlled by punch cards
  4. James Thomson - 1876 - tide calculating machine
  5. Herman Hollerith - 1890 - card system and machine to use it
  6. Dr. Howard Aiken - 1944 - automatic electro mechanical computer
  7. John van Neuman - 1946 - concept of stored programs

II. Hand Calculators

- A. Types
- B. Using the calculators
- C. The computer versus the calculator

III. The Computer

- A. Early machines
  1. ENIAC
  2. EDSAC
  3. UNIVAC I
- B. Three generations of computers
- C. The five functional units of the computer
- D. Digital analog and hybrid computers
- E. Number systems (bases) and their relationship to the computer
- F. Uses
  1. Computing
  2. Storage of information and retrieval
  3. Instruction (CAI)
  4. Others

IV. Computers in Society

- A. Future
- B. Careers

V. Programs

- A. Run some prepared programs

TOPICS FOR COMPUTER APPLICATION IN THE SCIENCE CLASSROOM

Many studies in science can be enhanced with the computer. Large numbers of programs are already available from various sources, and it is not difficult for the teacher (or student) with some programming experience to develop others.

The computer can be used in several significant ways to explore physical principles. 1) Events which would be costly or difficult to investigate in the laboratory can be simulated. In many cases, the program need not be complex for the exercise to be valuable. A simulation which varies with a physical law can be instrumental in the student's acquiring a feeling for the magnitude and extent of a concept. 2) Topics which involve a lot of calculation are ideally suited to computer exploration. The student can experiment with changing variables without the burden of long or repetitive calculation. This encourages exploration. 3) Computers can be used to acquaint the student with statistical and analysis techniques which might otherwise be too difficult. Statistical data analysis will help the student comprehend the approximate nature of experiments and may encourage more care and insight in laboratory exercises.

The following is a list of topics for which programs may already exist or be readily devised:

I. Physics

A. Vectors - resolution and composition. Calculations or graphics representations of components as functions of time, angle, etc.

B. Motion laws - demonstration of the effects changing one variable has on the others. Tutorial/drill in choosing the right equation. Developing approximation skills.

C. Friction - investigate the relationship between angle, normal force, coefficient of friction for objects on inclined planes.

D. Conservation laws - the relation between kinetic and potential energy of objects in a gravity or electrostatic field. Momentum conservation in inelastic collisions in one or two dimensions.

E. Impulse - the final velocity of a body (e.g., a rocket) subjected to a force F for a time t.

F. Waves - demonstration of superposition, reflection, refraction, standing waves, vibration modes. Single or double slit diffraction simulation. Doppler effect. Fourier analysis.

G. Inverse square laws - intensity of light, gravity, radio signals as a function of distance. Interaction between fields and particles or two massive bodies in space.

H. Electronics - the capacitance of two parallel plates of varying area, separation with different dielectrics. Ohm's law, especially for series/parallel combinations. Effects of changing a single component value on circuit operation. AC circuits--relations between impedance/reactance/frequency. Resonance determinations.

I. Relativity - mass, length, time effects of large velocities.

J. Atoms and subatomic particles - simulation of Millikan's oil-drop experiment. Electron energy as a function of quantum number. Ionization potential. Bohr's planetary model for the hydrogen atom.

K. Radioactivity - half-life calculations. Decay chain simulations. Carbon-dating simulation. Nuclear scaler simulation. Statistical analysis.

See pages 29-30 for two physics programs.

II. Chemistry

A. Calculation or instruction in the concept of molarity and/or normality.

B. Calculation of ratios in finding empirical formulas from percent composition.

C. Calculation of molecular formulas from empirical formula.

D. Calculation or instruction in pH.

E. Calculations and instruction in titrations and demonstration of titration curves.

F. Instruction in or calculations used in rate of reaction experiments.

G. Instruction in relationships involved in the Gas Laws, also graphing of these relationships.

H. Calculations involved in statistical analysis of experiments.

I. Instruction in the concepts of valence numbers and combining ratios.

See page 28 for a chemistry program that gives the ratio of elements in a formula.

III. Biology

A. Generation of genetic tables to predict characteristics or populations. (Examples are Life and Life for Two as found in *Basic Computer Games* by David Ahl.)

B. Calculation of cell growth or processes.

C. Production of biorhythms.

D. Simulation of population control. (Examples are Buffalo and Graze programs from the Minnesota Educational Computer Consortium.

E. Simulation in pollution control.

F. Simulation of food chains.

TOPICS FOR COMPUTER APPLICATION IN THE MATHEMATICS CLASSROOM

The computer can be used as a device to effectively aid learning. Such an approach would produce insight into the power of the computer as well as increase the understanding of the subject matter in various disciplines. The student would gain insight and understanding by writing simple programs implementing the material currently being covered. This method is especially suitable to the areas covered in mathematics.

Another method utilizes pre-written programs, which allows the student to perform difficult or tedious calculations, experiments involving large amounts of data, theoretical experiments, graphics, simulations, and to observe the effect when the variables are changed. While this method is applicable to mathematics, it is also suitable to other subject areas.

I. General Mathematics

A. Test for divisibility.

B. Finding the G.C.F. and L.C.M.

C. Testing numbers for primeness (pre-written).

D. Checkbook balancing.

E. Interest/percentage problems.

F. Finding averages of sets of numbers.

G. Drill and practice programs in basic operations (pre-written).

H. Converting from Fahrenheit to Celsius and the reverse.

II. Algebra

A. Plotting linear equations.

B. Solving quadratic equations using the quadratic formula.

C. Finding rational zeroes of a polynomial of degree n by approximation (pre-written).

D. Solving two equations in two unknowns.

E. Solving three equations in three unknowns using determinants (pre-written).

F. Logarithms and computation.

G. Find square root by successive approximation.

H. Matrix applications.

I. Finding the fallacy in the proof of 1 = 2.

J. Compound interest problems.

III. Geometry

A. Mid-point/distance/slope concepts of lines in two or three space.

B. Areas and volume formulas.

C. Pythagorean theorem/triplets.

D. Ratio and proportion.

E. Find the value of pi by the buffon needle method.

F. Determining types of triangles given the three sides.

IV. Advanced Mathematics

A. Vector applications (pre-written).

B. Area under a curve by approximation.

C. Maximum and minimum values of higher degree functions.

D. Composite functions.

E. Infinite series.

F. Finding value of e.

G. Rate of decay or half life.

H. Graphing trigonometric functions (pre-written).

V. Probability and Statistics

A. Mean/median/mode/standard deviation.

B. Coin flipping experiments.

C. Die tossing experiments.

D. Binomial distribution/Pascal's triangle.

E. Permutations and combinations.

STAR PROBE PROGRAM

This program may be used to demonstrate the effects of gravitation and changes in velocity components, gravitational constant, etc. It would be suitable for student experimentation after introduction to gravitation basics. The screen represents quite accurately position changes calculated from gravitation and motion laws. (TRS-80 Level II BASIC)

Note: b = blank (space)

```
   2  CLS:GO TO 2000
  10  VX=2E7:VY=000:V9=SQR(VX*VX+VY*VY):W=V9
  11  'VX,VY ARE PROBE INITIAL VELOCITY COMPONENTS
  20  A=3.0:'A IS FORCE LAW EXPONENT
  30  H=0:'H IS PROBE'S INITIAL HORIZONTAL POSITION
  40  SH=63:SV=23:'STAR POSITION IN SCREEN COORDINATES
  45  G=6.67E-11:'GRAVITATIONAL CONSTANT
  50  M=1E33:'MASS OF STAR (KG)
  60  C1=1E7:'ONE UNIT ON SCREEN=10000 KM
  70  T=1:'INITIAL TIME INCREMENT (BETWEEN PRINTS)
  71  'PROGRAM REDUCES T PROPORTIONAL TO ACCELERATION
  80  SR=(M/(4*3.1416*1E13))+(1/3):'STAR RADIUS
  84  PRINT"*bSPACE PROBE TRAJECTORY INITIALIZATIONb*":PRINT:PRINT
  86  INPUT"VERTICAL POSITION TO START,1 TO 47";V
  90  X=C1*(H-SH):Y=C1*(V-SV):'CONVERT TO SPACE COORD.
  92  D=.5:C2=G*M:C=1000:T1=0
  99  CLS:PRINT @20,"**bSPACE PROBE STAR PASSb**"
 100  'FLIGHT LOOP
 112  PRINT @479,"*";:'STAR
 115  R=SQR(X*X+Y*Y):T1=T1+T: IF R<SR THEN 250 ELSE B=T*C2/R+A
 130  AX=-X*B:AY=-Y*B:VX=VX+AX:VY=VY+AY:W=SQR(VX*VX+VY*VY)
 150  T=T/ABS(W/V9):V9=W:X=X+VX*T+D*AX*T:Y=Y+VY*T+D*AY*T
 153  IF E=1 THEN 170 ELSE RESET (H,V)
 170  H=INT(X/C1)+SH:V=INT(Y/C1)+SV:'CONVERT TO SCREEN COORD.
 171  E=0: IF H>127 OR H<0 OR V<0 OR V>47 THEN E=1:GO SUB 260:GO TO 177
 173  SET (H,V):'PROBE STROBE
 175  PRINT @724,"TIME:bb";T1;
 177  PRINT @788,"DISTANCE TO STAR:bb";R/C;
 180  PRINT @852,"PROBE VELOCITY:bb";W/C;
 190  A$=INKEY$: IF A$="b" THEN CLS:GO TO 84
 200  GO TO 100
 250  PRINT @724,"****bbPROBE HAS HIT THE STARbb***";
 255  PRINT:PRINT:PRINT:FOR Z=1 TO 1000:NEXT Z:GO TO 84
 260  PRINT @724,"::bPROBE OUT OF SCANNER RANGEb::";:RETURN
 299  '
2000  PRINT "THIS PROGRAM SIMULATES A SPACE PROBE ON A TRAJECTORY"
2010  PRINT "NEAR A WHITE DWARF STAR.THE PROBE STARTS ON THE"
2020  PRINT "LEFT SIDE OF THE SCREEN FROM A POSITION YOU DECIDE"
2030  PRINT "BY ENTERING A LINE NUMBER FROM 1 (TOP SCREEN) TO 47."
2040  PRINT "THE DISPLAY STARTS,USING THE INITIAL CONSTANTS IN LINES"
2050  PRINT"10-70 YOU CAN EXPERIMENT BY CHANGING THESE VALUES."
2060  PRINT "VELOCITIES ARE IN KM/SEC,X-Y COORDINATES (STAR AT"
2070  PRINT"0,0) ARE IN KM.TIME IN SECS.
2080  PRINT "IF AT ANY TIME DURING FLIGHT YOU WANT TO RESTART"
2090  PRINT "AT A NEW POSITION,TYPE A SPACE.
2100  PRINT:PRINT:INPUT "(TO BEGIN PRESS ENTER)";A$:CLS:GO TO 10
```

COEFFICIENTS OF FRICTION

The following program deals with the concept of coefficient of friction. It asks for the weight of a block and the angle of an inclined plane at which it will slide at uniform velocity. The program will calculate the force of friction and coefficient of friction and display the force of friction, coefficient of friction, sine, cosine, and tangent of the angle of incline. The object of the program is to show that the coefficient of friction is equal to the tangent of the angle of incline. If the students study the display, they should soon discover that they are indeed equal.

```
 10  PRINT TAB(20) "COEFFICIENTS OF FRICTION"
 20  FOR TL=1 TO 400:NEXT TL:CLS
 30  PRINT "THIS PROGRAM DEALS WITH AN EXPERIMENT WHERE YOU PUT A BLOCK
     ON AN INCLINED PLANE AND VARY THE ANGLE UNTIL THE BLOCK SLIDES AT
     UNIFORM VELOCITY"
 40  FOR TL=1 TO 4000:NEXT TL:CLS
 50  FOR X=1 TO 7
 60  PRINT "EXPERIMENT";X
 70  INPUT "WHAT IS THE WEIGHT OF THE BLOCK";FW(X)
 80  INPUT "AT WHAT ANGLE DOES THE BLOCK SLIDE WITHOUT ACCELERATION";B(X)
 90  CLS
100  NEXT X
110  PRINT "EX#";TAB(6)"FW";TAB(15)"ANG";TAB(22)"FF";TAB(31)"CF";TAB(40)
     "SIN";TAB(49)"COS";TAB(58)"TAN"
120  FOR X=1 TO 7
130  A=B(X)*.017453
140  FF=FW(X)*SIN A
150  NF=FW(X)*COS A
160  CF=FF/NF
170  PRINT TAB(1)X;TAB(4)FW(X);TAB(13)B(X);TAB(19)FF;TAB(27)CF;TAB(37)
     SIN A;TAB(46)COS A;TAB(55)TAN A
180  NEXT X
```

ELEMENTAL RATIOS FOR EMPIRICAL FORMULAS

The following program produces the ratios of different elements in a compound from their per cent composition in the compound and their atomic weights. It is useful as a calculating aid in this type of problem and in demonstrating the logic used to solve these problems. The output of the program gives the numerical ratios of the elements to each other but does not take into account fractional relationships. These are left for the student to simplify into whole numbers.

```
 1Ø  CLS
 2Ø  PRINT "ELEMENTAL RATIOS FOR EMPIRICAL FORMULAS"
 3Ø  PRINT
 4Ø  PRINT "THIS PROGRAM WILL CALCULATE THE RATIO"
 5Ø  PRINT "OF ELEMENTS IN A COMPOUND FROM THEIR"
 6Ø  PRINT "PER CENT COMPOSITION."
 7Ø  PRINT
 8Ø  PRINT "WHEN ASKED FOR THE NUMBER OF ELEMENTS IN"
 9Ø  PRINT "THE COMPOUND, TYPE THE NUMBER AND PRESS ENTER."
1ØØ  PRINT "IF A HYDRATED COMPOUND, WATER COUNTS AS ONE"
11Ø  PRINT "ELEMENT."
12Ø  PRINT
13Ø  PRINT "WHEN ASKED/FOR THE PER CENT COMPOSITION ENTER THE"
14Ø  PRINT "PER CENT AS GIVEN, A COMMA, AND THEN THE"
15Ø  PRINT "WEIGHT OF THE ELEMENT."
16Ø  PRINT
17Ø  INPUT "PRESS ENTER TO CONTINUE";BØ
18Ø  CLS
19Ø  LET S = 9999
2ØØ  INPUT "HOW MANY ELEMENTS ARE IN THIS COMPOUND";N
21Ø  CLS
22Ø  FOR X=1 TO N
23Ø  PRINT "WHAT IS THE PER CENT COMPOSITION AND ATOMIC WEIGHT OF
     ELEMENT";X;
24Ø  INPUT C(X),W(X)
25Ø  A(X)=(C(X)/1ØØ)/W(X)
26Ø  IF S<A(X) THEN 28Ø
27Ø  S=A(X)
28Ø  NEXT
29Ø  CLS
3ØØ  FOR X=1 TO N
31Ø  N(X)=A(X)/5
32Ø  PRINT "ELEMENT";X;"HAS THE NUMBER";N(X)
33Ø  NEXT
34Ø  PRINT
35Ø  PRINT
36Ø  INPUT "WILL YOU USE THIS PROGRAM? (YES OR NO)";A$
37Ø  IF A$="YES" THEN 18Ø
999  END
```

There are many problems in chemistry and physics that can be completed in a short time with the calculator. However, the microcomputer does motivate students, and if they are allowed to use a pre-written program or write their own, they may become interested in additional computer use. The act of writing a program may also give them further insight into understanding the problem.

Following are some problems that do not require elaborate programs, but at the same time, they could teach fundamentals.

CHEMISTRY

I. Percentage Composition

1. Calculate the percentage of nitrogen in $(NH_4)_2SO_4$.
2. Calculate the kilograms of iron available from 800 kg of iron ore hematite if the ore contains 58.6% Fe_2O_3.
3. Calculate the per cent of H_2O in copper II sulfate pentahydrate $CuSO_4 \cdot 5H_2O$.

II. Empirical Formula

1. Calculate the empirical formula for the compound with the following analysis: K is 26.6%, Cr 35.4%, and O 38.0%.
2. Calculate the empirical formula for a hydrated compound that has 18.28% calcium, 32.36% chlorine and 49.36% water.

III. Molecular Formula

1. What is the molecular formula of a nitrogen compound that has a molecular mass of 108 and 4.02% grams of nitrogen combined with 11.48 grams of oxygen?
2. What is the molecular formula of a hydrated sodium salt? Its formula mass is 248 and it contains 36.2% water of hydration. There is 18.50% sodium, 25.80% sulfur, 4.04% hydrogen and 51.50% oxygen.

IV. Gas Laws

1. 512 mℓ of hydrogen are collected at 23 °C and 812 mm of mercury. What will be the volume of the gas at STP? What would be the volume if collected over water?
2. A weather balloon is released from the ground. The volume of the balloon is 82 litres, with a ground level pressure of 743 mm of Hg and a temperature of 25 °C. What will be the volume of the balloon when it gets to a height where the pressure is 52 mm of Hg and a temperature of -60 °C?

V. pH

1. Calculate the pH and pOH of a solution having a concentration of .0098 mole H^+ per litre.
2. The pH of a 0.1 N acetic acid is 2.9. Calculate the pOH, the $[H^+]$ and the $[OH^-]$.

VI. Solubility Product

1. What is the Ksp of $CaCO_3$ if the residue after evaporation of 1.18 litres saturated solution is found to weigh 6.97 mg?

2. Calculate the molar solubility, the molar concentration of Ag^+ and CrO_4^{2-}, and the solubility in grams per 100 mℓ of silver cromate. The Ksp of $Ag_2 CrO_4$ is 1.9×10^{-12}.

VII. Mixtures

1. One pint of an alcohol solution contains 15% alcohol. How much pure alcohol (100% alcohol solution) must be added to make a solution which contains 35% alcohol?

VIII. General Gas Law

1. What will be the volume of 1,321 mℓ of a gas if the temperature changes from 25 °C to 60 °C and the pressure is increased from 30 inches of mercury to 32 inches of mercury?

IX. Molarity of a Solution If the Formula Is Given, the Amount of Water Is Given and the Amount of Solute Is Given

1. What will be the molarity of a solution if 25.23 grams of NaCl are added to 1,106 mℓ of distilled water?

X. Celsius to Fahrenheit

1. Given the Celsius temperatures from -10 °C to 10 °C, find the Fahrenheit temperature for each Celsius degree to two decimal points.

XI. Percentage Composition

1. After teaching the method of determining the formulas of a compound from its percentage composition, give the students the compound containing boron 3.6%, uranium 78.9%, nitrogen 4.6%, and potassium 12.00%. See who gets the right answer, B, U, N, K first.

PHYSICS

I. Vector Velocity

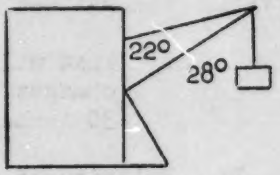
1. An airplane flies east at 758 km/hr. The wind is blowing toward the north at 48 km/hr. Calculate the magnitude and direction of the resultant velocity.
2. Calculate the direction and magnitude of the resultant of 73.0 m/sec. 25 degrees west of north and 108 m/sec. 30 degrees west of south.
3. A jet must fly at a ground speed of 710 km/hr and 15 degrees east of south. The wind is 45 km/hr and 48 degrees east of north. In what direction and at what speed must the jet fly?

II. Acceleration

1. An automobile can be accelerated from 22 km/hr to 71 km/hr in 8.9 seconds. Calculate the acceleration.
2. A steel ball is dropped from a bridge into a river. It took 2.2 seconds for it to hit the water. How high was the bridge above the water?
3. In the above problem what was the velocity of the ball when it hit the water?

III. Resolution of Forces -- Composition of Forces

1. A person pushes along the handle of a lawnmower with a force of 162.0 newtons. The angle between the ground and the handle is 40.0°. Calculate the horizontal and vertical components of the force.
2. The rafters of a garage roof meet at an angle of 98.0°. Calculate the force exerted along the rafters by an object weighing 7,500 newtons that hangs from the peak.
3. A block of granite having a mass of 1,875 kg is raised by a crane. The angle between the load cable and the boom is 28.0°. The boom is held by a tie cable which forms an angle of 22.0° with the boom. Calculate the push (force) on the boom and the pull (force) of the tie cable.



IV. Coefficient of Friction

1. A crate of appliances weighs 485 newtons. It is pulled across the floor at constant speed by a rope that makes an angle of 28.0° with the floor. If the force on the rope is 242 newtons, calculate the coefficient of sliding friction.
2. A crate slides down an incline of 12.5° at a constant speed. What is the coefficient of sliding friction?

V. Curvilinear Motion

1. Calculate the angular acceleration in radians per second of a wheel that attains an angular velocity of 554 revolutions per minute in 60 seconds.
2. A flywheel weighs 1,900 newtons and has a radius of 1.06 m. A force of 48.0 newtons is applied to the rim. Calculate how many seconds it will take for the flywheel to attain an angular velocity of 1,200 rev/min.

VI. Work -- Power

1. A crate with a mass of 110 kg is pushed up an incline that is 4.4 metres long. The angle of the incline with the horizontal is 24.0°. The coefficient of friction is 0.148. How much is done?
2. A water pump can pump 32 litres per minute. What power in kilowatts is needed to raise the water a distance of 7.25 metres.

VII. Storage Reservoir

1. Two pipes lead into a storage reservoir. Pipe A can fill the reservoir in 15 hours, while pipe B can fill it in 18 hours. Pipe B may also be used as an outlet to irrigate some land.
   a. How long will it take to fill the reservoir if pipes A and B are flowing in at the same time?
   b. How long will it take to fill the reservoir if pipe A is flowing in and pipe B is irrigating the land?

TEXTBOOKS

The texts below are now in use by various schools.

Excellent textbooks in the area of secondary computer science were not found as of this date by this committee.

Computer Programming in the BASIC Language, 1975
by Neal Golden
Harcourt Brace Jovanovich, Inc.

BASIC Programming, Second Edition, 1971
by Kemeny and Kurtz
John Wiley & Sons

Communicating with the Computer, BASIC, 1975
by Jacobs, French, Moulds, Schuchman
Allyn and Bacon, Inc.

REFERENCES

Computer science instructors wishing to enhance their knowledge in the areas related to computer science (BASIC-oriented) should consider the books listed below.

The starred items are those recommended as a starter list.

**The BASIC Handbook* ($14.95)
by David A. Lien
Compusoft Publishing
P.O. Box 19669
San Diego, CA 92119

**Basic Computer Games* ($8.50)
by David Ahl
Creative Computing Press
P.O. Box 789-M
Morristown, NJ 07960

Introduction to BASIC ($5.50)
Digital Equipment Corporation
Maynard, MA 01754

BASIC for Beginners
by Bitter and Gateley
McGraw-Hill Book Company

Computer Programming in the BASIC Language
by Jacobs, French, Moulds, Schuchman
Allyn and Bacon, Inc.

Computer Resource Book - Algebra
by Dwyer and Critchfield
Houghton Mifflin Company

A Guided Tour of Computer Programming in BASIC
by Dwyer and Kaufman
Houghton Mifflin Company

**Basic, BASIC*
by Coan
McGraw-Hill Book Company

Communicating With the Computer
by Jacobs, French, Moulds, Schuchman
Allyn and Bacon, Inc.

The First Book of Information Science
USAEC - Technical Information Center
P.O. Box 62
Oak Ridge, TN 37830

Computers
USAEC - Technical Information Center
P.O. Box 62
Oak Ridge, TN 37830

Introduction to Computer Programming With the BASIC Language ($12.95)
by Harvey M. Deitel
Prentice-Hall, Inc.

**Computers in the Classroom*
by Margolin and Misch
Macmillan & Co.

Computer Methods in Mathematics
by Albrecht, Lindberg, Mara
Addison-Wesley Publishing Co.

My Friend - The Computer
by Jean Rice
Denison

Fun and Games With the Computer
by Edwin Sage
ENTELEK

Game Playing With Computers
by Donald Spencer
Hayden Book Co.
Rochelle Park, NJ 07662

Some Common BASIC Programs
by Poole and Borchers
Adam Osborne and Associates
Berkeley, CA 94704

Chemistry With a Computer
by Paul A. Cauchon
Educomp Corporation
Hartford, CT 06101

Computers and Computation
From Scientific American

**Advanced BASIC*
by James S. Coan
Hayden Book Co.
Rochelle Park, NJ 07662

Programming Time-Shared Computers in BASIC
by Ergone H. Barrett
John Wiley & Sons

Introduction to Computers
by Alton R. Kindred
Prentice-Hall, Inc.

Music by Computers
Editors Forrster and Beauchamp
John Wiley & Sons

Problems for Computer Solution ($8.95)
by Gruenberg and Jaffray

**Problems for Computer Solution* ($3.95, Teacher's Ed. $9.95)
by Steve Rogowski

Program Style, Design, Efficiency, Debugging, and Testing
by Dennie van Tassel
Prentice-Hall

Computers and Their Societal Impact
by Martin Holoien
John Wiley & Sons

ERIC Center
University of North Dakota
Grand Forks, ND 58201

MECC - Minnesota Educational Computer Consortium
2520 Broadway Drive
Lauderdale, MN 55113

CONDUIT
P.O. Box 388
Iowa City, IA 52240

Digital Equipment Corporation
Maynard, MA 01754

PERIODICALS

Any school getting started in the wonderful world of computers should consider subscribing to at least one computer magazine from the list below. If only one magazine is purchased, its location should be in the library or some other location easily accessed by ALL students.

Below is a suggested list from which to choose. The committee felt the starred items should be your first consideration.

Interface Age - $14.00/year (hardware & business)
Interface Age Magazine
P.O. Box 1234
Cerritos, CA 90701

**BYTE* - $15.00/year (hardware, software, games, product reviews)(excellent)
BYTE Subscriptions
P.O. Box 590
Martinsville, NJ 08836

**Kilobaud* - $18.00/year (similar to *BYTE*)
Kilobaud
44 Main Street
Peterborough, NH 03458

Personal Computing - $14.00/year (12 issues) (games, applications, some hardware)
Circulation, Personal Computing
1050 Commonwealth Avenue
Boston, MA 02215

***Creative Computing* - $15.00/year (12 issues) (applications, software) (excellent)
Creative Computing
P.O. Box 789-M
Morristown, NJ 07960

Recreational Computing - $10.00/year (6 issues)
People's Computer Company
1263 El Camino Real
Box E
Menlo Park, CA 94025

CLOAD Magazine - $36.00/year (12 TRS-80 cassette tapes - 1/month)
CLOAD Magazine
Box 1267
Goleta, CA 93017

The Computing Teacher - $8.00/year (6 issues) (Professional)
The Computing Teacher
c/o Howard Bailey
Eastern Oregon State College
La Grande, OR 97850

GLOSSARY

Alphanumeric	:	The set of letters A-Z, the digits 0-9 and special characters.
Argument	:	An independent variable whose value determines the value of a function or operation.
Array	:	An ordered arrangement of elements in one or two dimensions.
ASCII Code	:	An acronym for American Standard Code for Information Interchange; a standardized code in which textual information is recorded.
BASIC	:	Beginners All-purpose Symbolic Instruction Code - a higher level programming language.
Baud	:	A rate of transmission of electrical signals - usually equivalent to bits per second (BPS).
Binary Number	:	A number consisting of only zeros and ones that is represented in the binary (base two) number system.
Bit	:	A binary "digit," i.e. 0 or 1, the smallest memory cell in a computer.
Buffer	:	A temporary storage area used to contain data.
Bugs	:	Errors in a computer program.
Byte	:	8 consecutive bits - the smallest memory cell referenced by BASIC. Most small computers process information one byte at a time.
Card Reader	:	A machine used to detect holes in punched cards. It then sends signals to a computer to translate the information from the holes.
Cathode Ray Tube (CRT)	:	A machine, with a keyboard like a typewriter and a TV screen, which can be used as both an input and output device.
Central Processing Unit (CPU)	:	That portion of a computer system that controls the interpretation and execution of instructions.
COBOL	:	An acronym for Common Business Oriented Language.

Command	:	An instruction to the computer operating system describing an action on the program.
Compiler	:	A computer program that translates a user-written program into machine language.
Computer	:	A device capable of accepting information, processing that information, and providing a result.
Constant	:	A constant represents a fixed numerical value.
Control Unit	:	A part of the computer that directs the flow of data through the computer which is located in the CPU.
Data	:	The information a computer needs to solve a problem.
Debug	:	To remove errors from a computer program.
File	:	An organized collection of related data.
Floppy Disk	:	A flexible magnetic diskette used to store large files of information (such as 50 K to 250 K bytes).
Firmware	:	Software that has been incorporated in the hardware.
Flow Chart	:	A drawing or map that tells the steps needed to solve a problem. It also shows the correct order for doing the steps.
FORTRAN	:	An acronym for Formula Translator; a procedure-oriented programming language designed for scientific applications.
Generations	:	Computer generations refer to groups of computers using certain kinds of parts. For example, first generation computers used vacuum tubes.
Hardware	:	The physical equipment or machinery that composes a computer system.
Hexadecimal Number	:	A number represented in the base 16 number system having "digits" 0-9, A-F.
Increment	:	To add a quantity to another quantity.
Input	:	Information that goes into the computer.
Input/Output (I/O)	:	The exchange of information between a computer's CPU and any external device (a keyboard, cassette player, etc.).

Integrated Circuit (IC) (or chip)	:	One complete electronic circuit in one sealed package, such as a microprocessor, a block of memory.
Interface	:	Electronic circuitry used to connect two pieces of computer equipment.
Interpreter	:	A computer program that translates a high level language, BASIC, into machine language for computer processing.
Keyboard	:	A device that encodes data by converting a pressed character key into an electrical signal.
Kilobyte (K)	:	2^{10} or 1024 bytes.
Log-In	:	To access a computer system.
Machine Language	:	The binary-coded language used directly by the computer.
Magnetic Disk	:	A device which looks like a phonograph record. It contains information which can be sent to the computer.
Magnetic Tape	:	A plastic ribbon, which resembles tape recorder tape. Information is recorded on the tape in the form of magnetized spots.
Magnetic Tape Drive	:	A machine used to detect the spots on magnetic tape. (A cassette recorder).
Memory	:	The part of the computer where programs and data are stored.
Nanosecond	:	A billionth of a second.
Octal Number	:	A number represented in base 8 number system having digits 0-7.
Off-Line	:	Using a computer terminal when it is not hooked up to a computer.
On-Line	:	Using a computer terminal when it is hooked up to a computer.
Output	:	A device involved in transferring data from memory to an external device such as a printer or video display.
Paper Tape	:	A paper ribbon that contains information in the form of patterns of holes.
Paper Tape Reader	:	A machine used to detect the holes on paper tape.
Peripheral	:	Any device which is connected to the computer, but not part of the main "box." (A cassette player, floppy disk, teletype, etc.)
Plotter	:	An external device used in producing graphical hard copy output.
Print Out	:	A form of output from a computer which

		contains the information the computer has just processed. It is also called a read out.
Printer	:	The machine used to print the output from the computer.
Program	:	A set of instructions which tells the computer what to do.
Programmer	:	A person who writes a computer program.
PROM	:	Programmable Read Only Memory.
Random Access Memory (RAM)	:	Memory available to the users for storage of programs and data.
Read Only Memory (ROM)	:	Memory which is permanently programmed and may be read from but not written to. Used to store the BASIC interpreter.
Sequential File	:	A storage unit that uses the technique in which data only becomes available in a one-after-the-other sequence.
Serial I/O	:	The process of a CPU exchanging information with a peripheral device one bit at a time (over 1 wire). A teletype or cassette player communicate in this fashion.
Software	:	The programs that go into the computer.
Source Language	:	A language used by programmers to write a computer program.
Statement	:	A line of a computer program.
Statement Number or Line Number	:	A number at the beginning of a statement in a computer program.
String	:	A sequence of alphanumeric characters of length from zero (the null string) to 255.
Terminal	:	A device, consisting of a keyboard and display mechanism, used to enter and receive data from a computer.
Time-Sharing	:	A computer system where many people use the computer at the same time.
Variable	:	A quantity whose value may vary as instructions change throughout the program.
Variable Name	:	The label used to refer to a particular variable.
Video Monitor	:	See CRT.

CAI SPELLING PROGRAM

Most have 16K Level II Radio Shack. To use as is.

```
  5  CLEAR 10000
 30  DIM E$(49),Z(49),A$(49),C$(29)
 45  REM N=NUMBER OF WORDS, P1,P2,P3 ARE POINTS FOR CORRECT ON TRY 1,2,3
 50  READ N,P1,P2,P3
 55  RANDOM
 56  REM SELECT ORDER TO SHOW WORDS
 60  FOR V=0 TO N-1
 70  X=RND(N)
 80  FOR P=0 TO V
 90  IF X=Z(P) THEN 70
100  NEXT P
110  Z(V)=X
120  NEXT V
130  FOR X=0 TO N-1:Z(X)=Z(X)-1:NEXT X
200  REM READING WORD LIST
210  FOR I=0 TO N-1:READ E$(Z(I)):NEXT I
220  REM ZEROING OUT C$(I)'S
221  FOR I=0 TO 29:C$(I)="":NEXT I
230  REM SETTING POSITIVE RESPONSES
232  J$(1)="RIGHT ON":J$(2)="SUPER JOB":J$(3)="YOU GOT IT":J$(4)="KEEP UP
     THE GOOD WORK"
299  CLS 'DIRECTIONS
300  INPUT "PLEASE TELL ME YOUR NAME";N$
305  INPUT "DO YOU WANT INSTRUCTIONS (YES OR NO)";A$
310  IF A$="NO" THEN 500
330  PRINT "YOU WILL BE SHOWN A WORD.  WHEN THE QUESTION MARK APPEARS":
     PRINT "YOU TYPE IN THE WORD YOU JUST SAW."
335  PRINT "IF YOU MAKE A MISTAKE I WILL GIVE YOU SOME HELP"
340  PRINT:PRINT "YOU WILL GET";P1;"POINTS FOR A CORRECT ANSWER ON THE
     FIRST TRY."
341  PRINT "YOU WILL GET";P2;"POINTS ON THE SECOND TRY AND";P3;"ON THE
     THIRD TRY."
345  PRINT "I WILL TELL YOU YOUR SCORE WHEN WE ARE DONE"
346  PRINT "TYPE ANY KEY WHEN YOU ARE READY TO BEGIN"
385  F$=""
390  F$=INKEY$:IF LEN(F$)=0 THEN 390
500  REM PUTTING WORDS ON SCREEN AND CHECKING ANSWER.
510  CLS
520  FOR M=0 TO N-1
530  C$=E$(M):T=0
535  FOR P=1 TO LEN(C$):C$(P-1)=MID$(C$,P,1):NEXT P
540  PRINT CHR$(23);C$
550  FOR X=1 TO 500:NEXT X:CLS 'TIMER FOR TIME WORD SHOWN
560  IF T>=3 THEN PRINT "THE CORRECT SPELLING IS"C$
570  IF T=3 THEN W=W+1
580  INPUT A$
590  IF LEN(A$)=0 THEN 630
600  T=T+1
610  IF A$=C$ THEN 1000
620  IF A$<>C$ THEN 2000
630  PRINT "I'M SORRY I DIL NOT GET YOUR ANSWER":PRINT "PLEASE REENTER
     IT":GO TO 580
690  FOR H=1 TO LEN(C$):C$(H-1)="":NEXT H
```

(CONTINUED)

```
 7ØØ  NEXT M
 71Ø  GO TO 3ØØØ
1ØØØ  REM ROUTING IF CORRECT
1Ø1Ø  PRINT J$(RND(4));" ";N$: FOR Q=1 TO 1ØØØ:NEXT:CLS
1Ø2Ø  ON T GO TO 1Ø3Ø,1Ø4Ø,1Ø5Ø
1Ø3Ø  C1=C1+1:GO TO 69Ø
1Ø4Ø  C2=C2+1:GO TO 69Ø
1Ø5Ø  C3=C3+1:GO TO 69Ø
2ØØØ  REM ROUTINE FOR INCORRECT ANSWERS
2Ø1Ø  FOR I=Ø TO 29:A$(I)="":NEXT
2Ø2Ø  FOR I=1 TO LEN(A$):A$(I-1)=MID$(A$,I,1):NEXT
2Ø5Ø  FOR I=1 TO LEN(C$)
2Ø6Ø  IF A$(I-1)=C$(I-1) THEN H$=H$+A$(I-1):GO TO 21ØØ
2Ø7Ø  H$=H$+"-"
21ØØ  NEXT I
22ØØ  PRINT H$
23ØØ  GO TO 56Ø
3ØØØ  CLS:PRINT "WELL";N$;" YOU HAVE COMPLETED THE LIST OF";N;"WORDS":
      PRINT "LET'S SEE HOW YOU DID"
3Ø1Ø  PRINT:PRINT "YOU GOT";C1*P1+C2*P2+C3*P3;"POINTS"
3Ø2Ø  PRINT "YOU MISSED";W;"WORDS"
3Ø3Ø  END
4ØØØ  DATA 1Ø,1Ø,8,6
4Ø1Ø  DATA TODAY, FOX, RED, HELP, NOW, BABY
4Ø2Ø  DATA ENCYCLOPEDIA, BISMARCK, PRINT, NORTH DAKOTA
```

COMPUTER CAREERS

A. Clerical and Keypunching

1. Clerical jobs
   a. Coding of data
   b. Checking of totals used for accounting controls
   c. Maintaining of libraries of tape files
   d. Operating schedules
   e. Requirements
      1. High school diploma usually required
      2. Provides on-the-job training

2. Keypunching jobs
   a. Punching data on cards
   b. Typing onto magnetic or paper tape
   c. Operating other data recording devices
   d. Requirements
      1. The ability to type reasonably well
      2. Several weeks of intensive training

B. Computer Operators

1. Reviews computer programs and instruction sheets

2. Determines the necessary equipment for each job

3. When machine stops, must investigate and correct the stoppage or call in a maintenance engineer

4. Keeps a log on the work done on the computer

5. Prepares a report on the computer's use

6. In large installations he may be assisted by
   a. Tape librarians and handlers
   b. Operators of auxillary equipment

7. Requirements
   a. At least a high school diploma
   b. Possibly some college or technical background

C. Programmers

1. Devises a detailed plan for solving specific problems
   a. Plan is called a program which consists of a series of coded, step-by-step instructions
   b. Works with different computers
   c. Deals with various computer languages
   d. Problems can be very routine or very complex

2. Checks his program to make sure it is free from errors
   a. Done by preparing sample data and testing it on the computer

3. Often works as a team

4. Frequently specializes
   a. Scientific applications programmer
      1. Writes programs to solve engineering and scientific problems
      2. College degree required and advanced degree desirable
   b. Business applications programmer
      1. Must deal with a variety of business problems
      2. College degree desirable
   c. Systems programmer
      1. Writes instructions that make it easier to program computers
      2. Writes programs that keep track of what the computer is doing
      3. Writes programs that let the computer do many things at the same time
      4. College degree is usually required
      5. Must be very knowledgeable as to how the computer functions

D. Systems Analysts

1. Helps devise ways of getting information to the computer

2. Defines the way necessary to turn data into useful information

3. Plans the distribution and use of results

4. In smaller organizations the work of a systems analyst and programmer are often combined

5. Requirements
   a. College degree
   b. Often two or more years of programming experience
   c. Possibly some business experience
   d. The ability to reason logically very important

E. Customer Service or Field Engineering

1. Installs, services, and maintains computers to keep them operating satisfactorily

2. College degree in engineering helpful but not always necessary

3. Factory training may be provided but experience and training in electronics is very helpful

F. Marketing and Sales

1. Computer salesman

2. Many specialize in certain areas
   a. Business
      1. Must be familiar with all phases of company organization
      2. Must know details of modern management

b. Particular industry
c. Scientific applications

3. Requirements
   a. College graduate
   b. Experience in sales in allied technical or management fields
   c. Degree may be in business, engineering, or scientific disciplines
   d. Job generally begins with an extensive training course

G. Designing and Manufacturing

1. Mainly consists of scientists and engineers working in research

2. Work on developing better techniques, materials and equipment for computers

3. Turn ideas into actual products

4. Requires college degree and advanced degrees are often necessary

H. Salaries for Computer Careers

1. Generally above the average

2. Reflects the skills required

I. Places where computers are used

1. Mathematical work
2. Scientific work
3. Military use
4. Business
5. Telephone companies
6. Schools
7. Offices
8. Television companies
9. Radio stations
10. Internal Revenue Service
11. Police stations
12. Agriculture
13. Industry
14. Space program
15. Elections
16. Census
17. Weather
18. Transportation
19. Universities and colleges
20. Banks
21. Employment office
22. Social security

FLOW CHARTING

Step-by-step problem-solving procedures are known as algorithms, a word derived from the name of al-Khowarismi, a famous 9th century Asian mathematician who invented the "shift and add" algorithm for multiplying decimal numbers. Unfamiliar though the word may be to most of us, we all use algorithms in our daily lives. For example, an algorithm designed to get you to class each morning might be: get up, wash, dress, eat breakfast, run to the street corner, catch the school bus. Is each stop absolutely essential? Not really; you could omit washing and breakfast. Clearly the algorithms of our daily living can be broad, flexible, and fuzzy. For computer problem solving however, algorithms must be expressed as tightly organized, unambiguous sequences of instructions which lead to answers in a finite amount of time. To help make a transition from the imprecise nature of a problem stated in English to the precise computer algorithm, programmers commonly use an intermediate step called flow charting. We will illustrate this procedure with an example drawn from everyday life.

Suppose we are given the problem of describing, to another person, the procedure for sharpening a pencil. In order to clearly describe the sequence of steps to be carried out, we will construct a flow chart. The beginning and end of the algorithm will be represented by a small oval. Each specific operation to be carried out will be contained in a rectangle. Our first flow chart of the algorithm is shown on the next page.

Careful examination of flow chart Figure 1 reveals several inadequacies in the algorithm. For example, a person using this procedure could grind his pencil to a stub, as no indication is made concerning the number of times to turn the handle. A refined or more precise form for this algorithm may be seen in Figure 2.

Anyone who has ever sharpened a pencil should recognize that turning the handle three times does not guarantee a sharp pencil. The procedure is more accurately described as one of turning the handle three times, removing the pencil, and answering the following question. "Is the pencil sharp?" If the answer is "no," the pencil is returned to the sharpener and the whole process is repeated. This repetition continues until we are able to answer the question with "Yes, the pencil is sharp." Only then do we return to our seat. Since our goal is to precisely describe the process of sharpening a pencil, we must introduce these ideas of decision making and repetitive operations into our flow chart. The diamond-shaped figure is normally used in flow charting to represent the decision-making step in an algorithm. This symbol is displayed in the refined flow chart in Figure 3.

The flow chart illustrates how decision making may be used to direct repetitive operations. This procedure is called looping. A fourth refinement of this flow chart, shown in figure 4, displays additional logic loops related to this algorithm.

Consider the flow chart in Figure 5 and answer the following questions.

1. Will this algorithm result in a sharpened pencil?
2. What is the essential difference between this flow chart and the one shown in Figure 4?
3. Which algorithm would you rather use? Why?

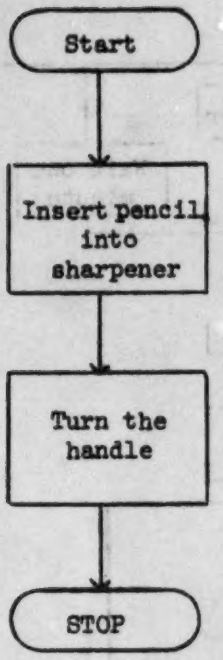


Figure 1

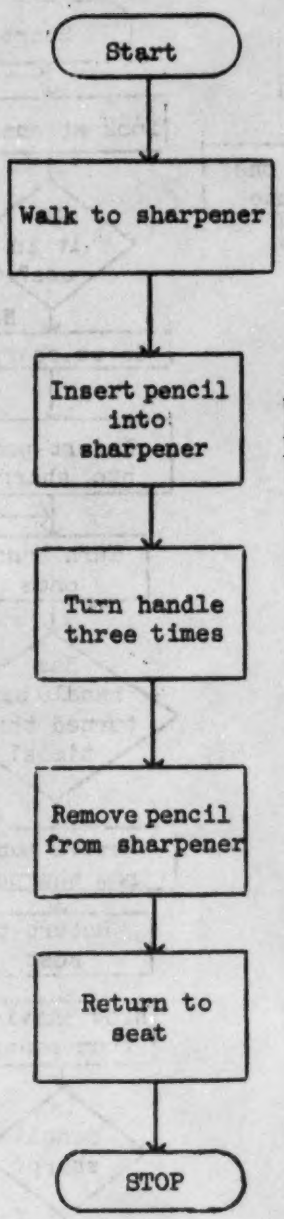


Figure 2

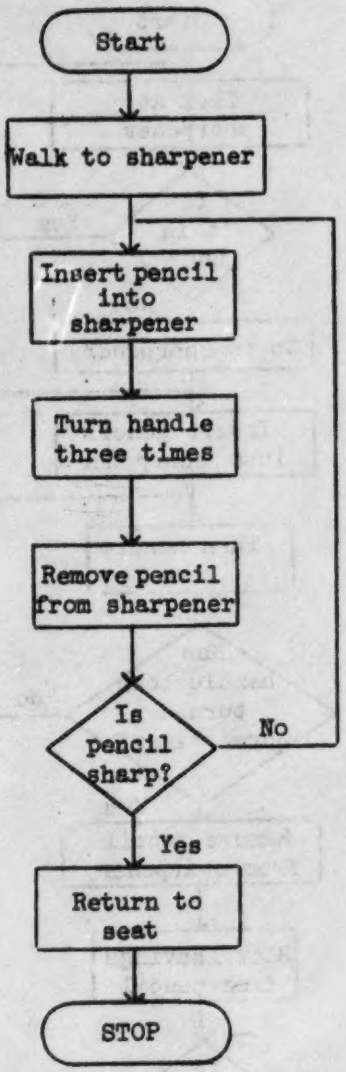


Figure 3

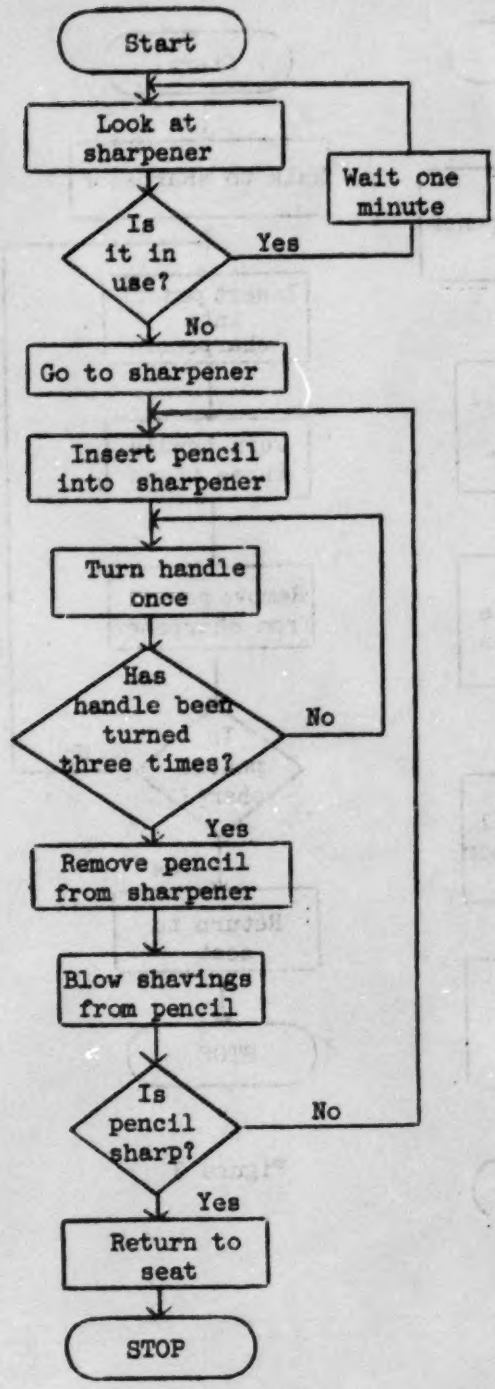


Figure 4

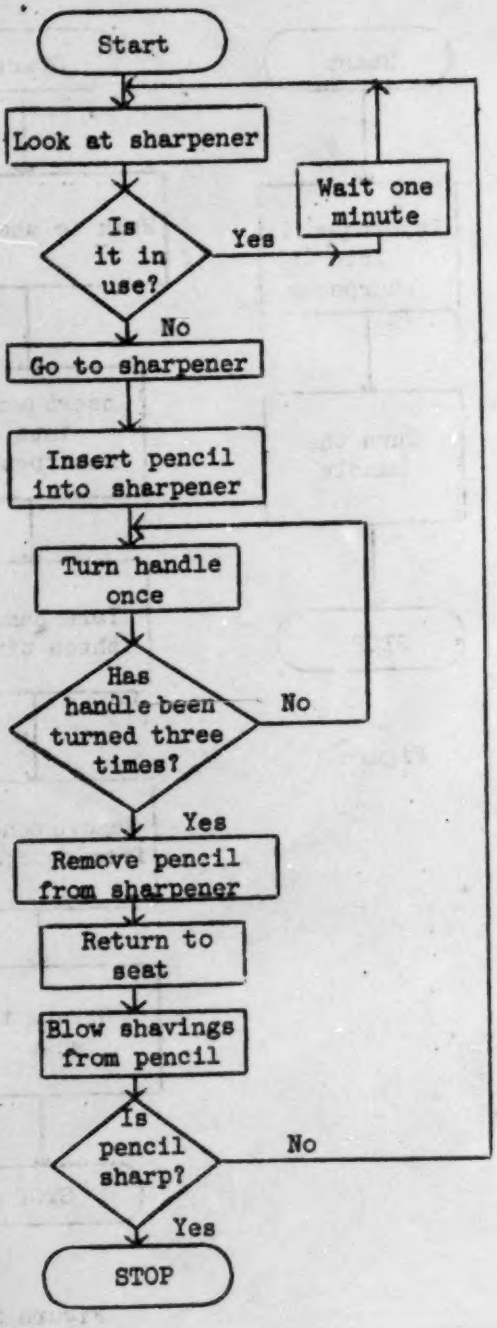


Figure 5